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NIGHT TELEVISION SYSTEM.(U)
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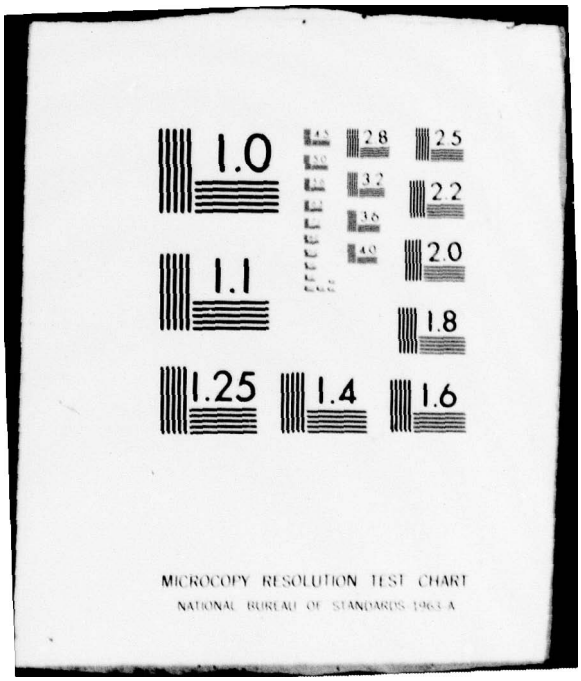
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USAEPG-SIG 930-170

FINAL REPORT

NIGHT TELEVISION SYSTEM

(TASK 24-57-0312)

U.S. ARMY ELECTRONIC PROVING GROUND

FORT HUACHUCA, ARIZONA

JANUARY 1961

HEADQUARTERS

U.S. ARMY ELECTRONIC PROVING GROUND

Fort Huachuca, Arizona

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ALEXANDER NICOLINI
Major, Infantry
R&D Coordinator

(9) FINAL REPORT

(6) WIGHT TELEVISION SYSTEM

(TASK 24-57-0312)

(10) WILLIAM A. MCKEEN, Task Manager

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Combat Surveillance Department
U. S. Army Electronic Proving Ground
Fort Huachuca, Arizona
January 1961

Reviewed by USAEPG, Combat Developments Directorate, Plans Division:

J. W. KOHNSTAMM
Major, SigC
Tech/Tact Advisor, Test Plan and Review Branch

Approved by:

ROY F. BLACKMON
Colonel, SigC
Chief, Combat Surveillance Department

WILLIAM M. HAYCOCK
Colonel, GS
Acting Director, Combat Developments Directorate

FINAL REPORT

NIGHT TELEVISION SYSTEM

TASK 24-57-0312

OBJECTIVE

The objective was to determine the effectiveness of the 6849 Image Orthicon TV Camera Tube as a light sensitive pickup device in a television system for use during the hours of darkness.

AUTHORITY

This test was conducted by authority of CDOG 1522k and 1540j SIOCCD 59-2 and 59T5 COP FY-59 2a(3)(a)5, and is documented under Task 24-57-0312, "Evaluation of Night Television System," of the USAEPG Technical Program.

Combat Surveillance Department
U. S. Army Electronic Proving Ground
Fort Huachuca, Arizona

January 1961

SUMMARY

Tests were conducted during a 15-month period from January 1957 to March 1958 to determine the effectiveness of the type 6849 Image Orthicon Camera Tube manufactured by Radio Corporation of America, as a light-sensitive pickup device when used in television camera systems during the hours of darkness.

Three lenses were used during the tests: An f/0.87 76mm, an f/1.9 50mm, and an f/3.8 135mm. Preliminary tests under low light level conditions revealed that the f/0.87, 76mm Super-Farron high speed objective lens, manufactured by the Farrand Optical Company, New York City, New York, was the only lens of those tested which yielded useful imagery.

Field tests were conducted over the period 10 days before and 10 days after full moon under "visibility unlimited" conditions. Controlled laboratory tests were conducted using incandescent lamps for illumination.

Results indicated that:

1. The type 6849 camera tube would yield useful information only during the period 5 days before and 5 days after full moon utilizing the f/0.87 76mm lens.

2. Under moonlight conditions, objects which were not visible to the unaided eye were detected and identified at ranges up to 400 yards.

3. Modification of the camera by allowing the tube to store the picture increased the sensitivity, but the flicker introduced by blanking the camera tube caused eye fatigue.

4. Resolution of the camera tube was approximately 500 television lines (horizontal) with an illumination level of 1 foot-candle. Under full moonlight (from 10^{-2} to 10^{-3} foot-candles) resolution was reduced to approximately 150 television lines.

5. The sensitivity of the camera tube using the f/0.87 76mm lens was satisfactory at light levels down to 10^{-2} - 10^{-3} foot-candles (moonlight).

It was concluded that:

1. Type 6849 Image Orthicon TV Camera Tube does not possess adequate sensitivity to be utilized in television cameras for

surveillance during the hours of darkness when illumination level is below 10^{-3} foot-candles.

2. The general concept has application to the combat surveillance system, but a more sensitive tube is required to make military use practical.

3. The speed of the f/0.87 lens appears adequate. The 76mm focal length is insufficient to detect targets at ranges in excess of 500 yards during periods of low illumination.

It is recommended that:

1. The 6849 Image Orthicon Camera Tube receive no further consideration for combat surveillance system applications.

2. A more sensitive tube be developed. (This tube should be most sensitive in the yellow or red portions of the light spectrum since spectral energy is greatest in those regions during the hours of night sky illumination).

3. A system having usable sensitivity at low light levels down to 10^{-9} foot-candles (equivalent to overcast starlight) with suitable lenses should be developed.

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I. BACKGROUND

The Army has long recognized television as a medium for obtaining intelligence information. The use of military television in the past has been restricted to daylight hours. Night tests were conducted at USAEPG in early 1955 using the commercial 5820 image orthicon tube. Test results showed little information content 1/2 hour after sunset and no information 1 hour after sunset during the full moon.

A passive sensory device capable of detecting and identifying enemy personnel, vehicles and other targets during the hours of darkness would be a valuable asset to the combat surveillance system.

The 6849 camera tube was an experimental tube first designated C-73410 by the manufacturer. The difference between this tube and the conventional 5820 used in broadcast television was the greater spacing between the target glass disc and the mesh components within the tube. Two of these tubes were received in December 1956 for test and evaluation.

II. DESCRIPTION OF MATERIEL

The following equipment and light sources were used during the test:

1. The standard RCA broadcast television camera chain type TK-31A consisting of camera, viewfinder, camera control, synchronizing generator, and power supply.

2. The Model A-2 airborne television system consisting of camera, camera control box, monitor, dynamotor, power junction box, transmitter and receiver.

3. The RCA type 6849 Image Orthicon TV Camera Tube was used in the television systems (Figure 1).

4. The f/0.87, 76mm Super-Farron high speed objective lens (Figure 2), an f/1.9 50mm lens, and an f/3.8 135mm lens were used in the television systems.

5. A 60-watt incandescent lamp with a variable voltage transformer was used in a darkroom for controlled lighting.

6. A 4- x 5- inch speed graphic camera was used to record the image on the television monitor.

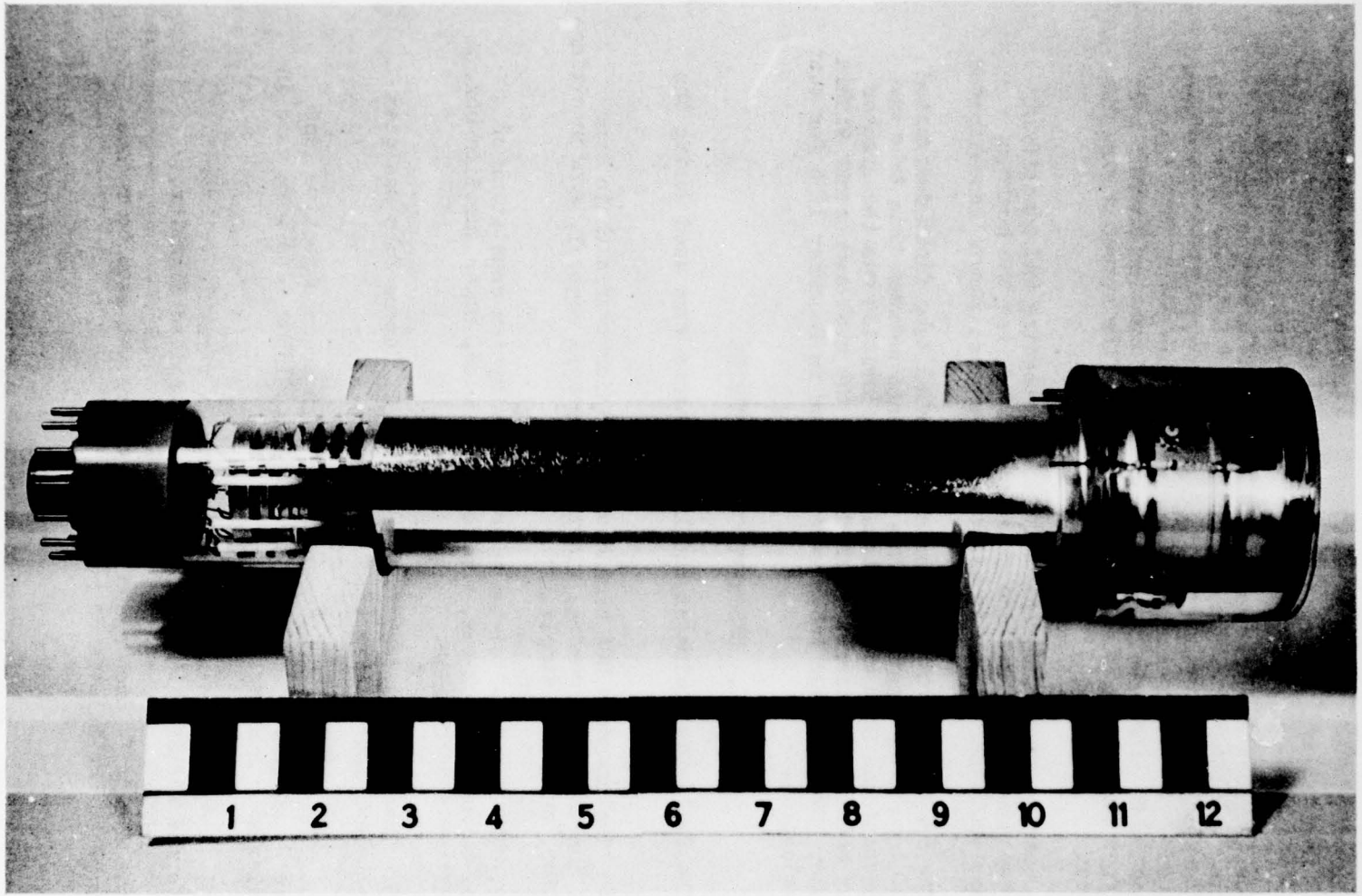

Figure 1. RCA type 6849 Image Orthicon TV Camera Tube

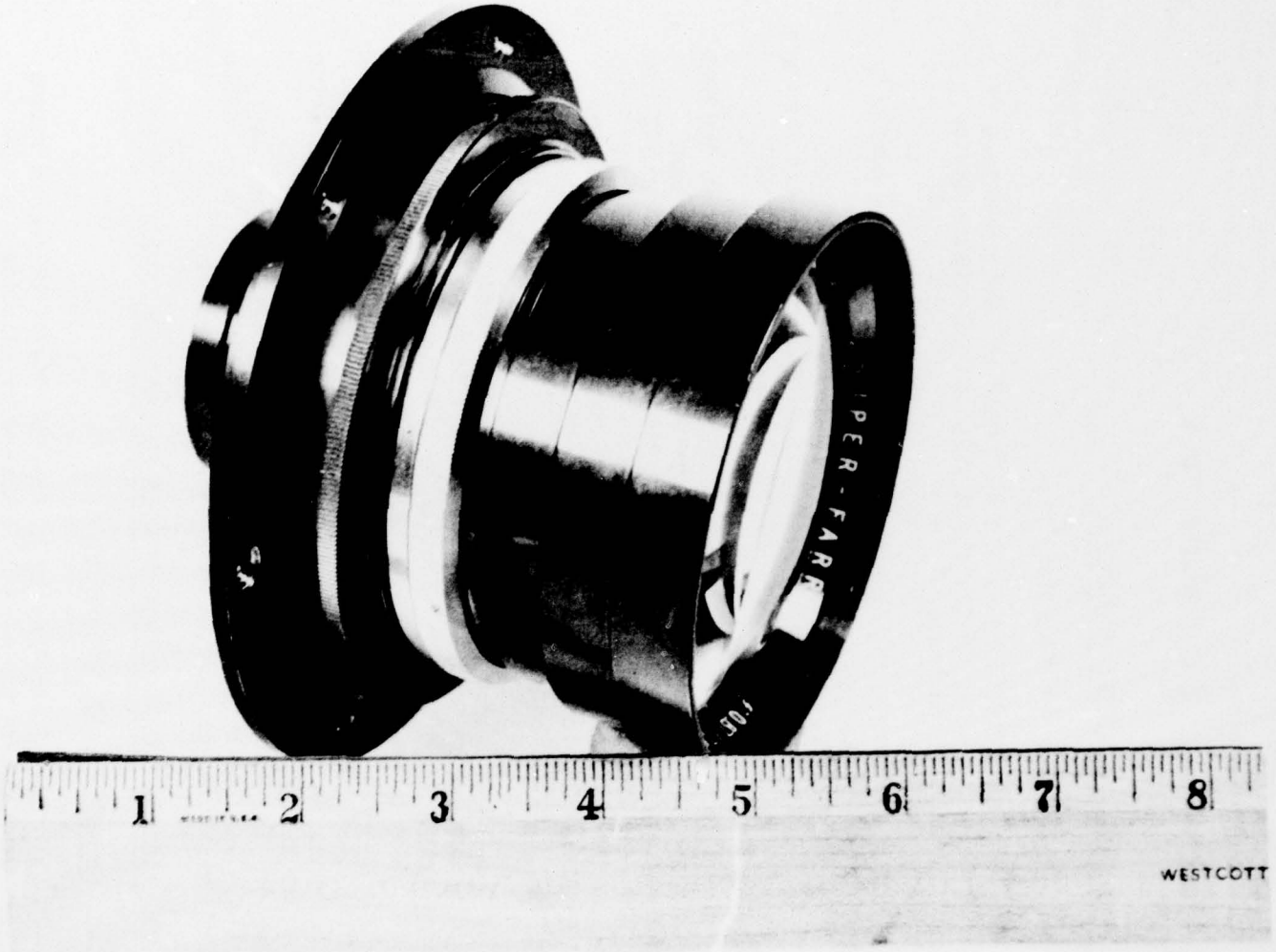

Figure 2. f/0.87 76mm Super-Farron high-speed objective lens

III. SPECIFIC TESTS

1. TEST NR 1 - AIRBORNE OPERATION.

a. Objective. To determine:

(1) The effectiveness of the type 6849 Image Orthicon TV Camera Tube as a pickup device in an airborne television system during the hours of darkness.

(2) Intensity of illumination required to obtain useful imagery from the equipment using this tube.

(3) The most advantageous altitude and speed of the aircraft and types of lenses.

b. Method. The type 6849 camera tube was installed in the Model A-2 airborne television system. The camera equipment was then installed in an H-19 helicopter and flown at altitudes from 500 feet to 1,500 feet above terrain between sunset and sunrise. Motor pools, vehicles, buildings, and terrain varying in contrast were used as targets. Kodak Ecktanon lenses f/1.9 50mm and f/3.8 135mm were used on the camera.

c. Results. The equipment would yield results only during the period 5 days before and 5 days after the full moon (10^{-2} - 10^{-3} foot-candles) with the f/1.9 50mm lens. The objects which could be detected were light-colored objects on a dark background; however, identification of the objects could not be made. Lights from buildings and vehicles caused the camera tube to saturate, losing all information. There was no overcast and visibility was unlimited. Altitudes to 1,500 feet and speeds to 75 knots made little difference in sensitivity. The f/3.8 135mm lens yielded no useful results. Results indicated that a faster lens would be required to obtain useful imagery during night airborne operations.

2. TEST NR 2 - GROUND OPERATION WITH EQUIPMENT MODIFICATIONS.

a. Objective. To determine:

(1) If the sensitivity of the RCA TK-31A TV camera system with the 6849 camera tube can be enhanced by allowing the tube to store the image for a longer period.

(2) If resultant flicker caused by camera modifications will adversely affect recognition of targets.

(3) If the type 6849 camera tube and modified television equipment can be utilized as a night-ground television surveillance device using the f/1.9 50mm lens.

b. Method. The RCA TK-31A television camera was modified to let the target element of the tube store the image for a one-second period before reading the information. The equipment was then set up in the laboratory and tests were made, using a variable voltage transformer controlling the voltage to an incandescent lamp for illumination. In the field tests, moonlight was used for illumination and personnel and vehicles were utilized as targets. The tests were repeated without the camera modifications to determine the difference in sensitivity.

c. Results. Results indicated that:

(1) The sensitivity was doubled by using the modified increased storage method.

(2) The resultant flicker on the monitor caused by the modification made military target recognition difficult.

(3) The equipment yielded results only during the period 5 days before and 5 days after the full moon.

(4) Vehicles and personnel could be identified as such at ranges up to 100 yards using the modified camera and the f/1.9 50mm lens. The unmodified camera using the same lens permitted identification up to only 35 yards. Resolution in both cases was less than 75 TV lines. There was no overcast and visibility was good.

3. TEST NR 3 - GROUND OPERATION WITH EQUIPMENT MODIFICATIONS AND SPECIAL LENS.

a. Objective. To determine:

(1) If modification of the equipment as performed in Test Nr 2, in addition to a high speed lens, enhances system performance during the various phases of illumination encountered during the hours of darkness.

(2) Intensity of illumination necessary to allow identification of objects.

(3) The gain in system's sensitivity by utilizing the

f/0.87 76mm lens without equipment modifications.

b. Method. The equipment was modified as in Test Nr 2 and the f/0.87 76mm lens was mounted on the camera. The equipment was operated in the field during the period 10 days before and 10 days after the full moon. Personnel and vehicles were used as targets. The camera was returned to its original configuration and the tests were repeated utilizing the high speed lens.

c. Results. Results indicated that:

(1) Identification of vehicles and personnel at ranges up to 400 yards was possible without camera modifications (Figures 3 thru 7).

(2) Camera modifications increased sensitivity but the resultant flicker on the monitor made target identification difficult.

(3) The system with and without modification was limited to operation during the period 5 days before and 5 days after the full moon with no overcast and good visibility.

4. TEST NR 4 - AIRBORNE OPERATION WITH HIGH SPEED LENS.

a. Objective. To determine:

(1) If the type 6849 camera tube with high speed lens can be utilized as a pickup device in airborne television systems during the hours of darkness.

(2) Intensity of illumination necessary for identification of targets.

(3) Optimum altitude and speed of airborne platform for identification of targets.

(4) Maximum altitude and speed of airborne platform for identification of targets.

b. Method. The A-2 airborne television system and the f/0.87 76mm lens with the 6849 camera tube were installed in an H-19 helicopter. The equipment was flown at altitudes ranging from 500 feet to 2,000 feet above terrain at speeds up to 75 knots. Buildings, roads, vehicles, and personnel were used as targets.

Figure 3. Men and vehicles at 75 and 150 yards (full moon)

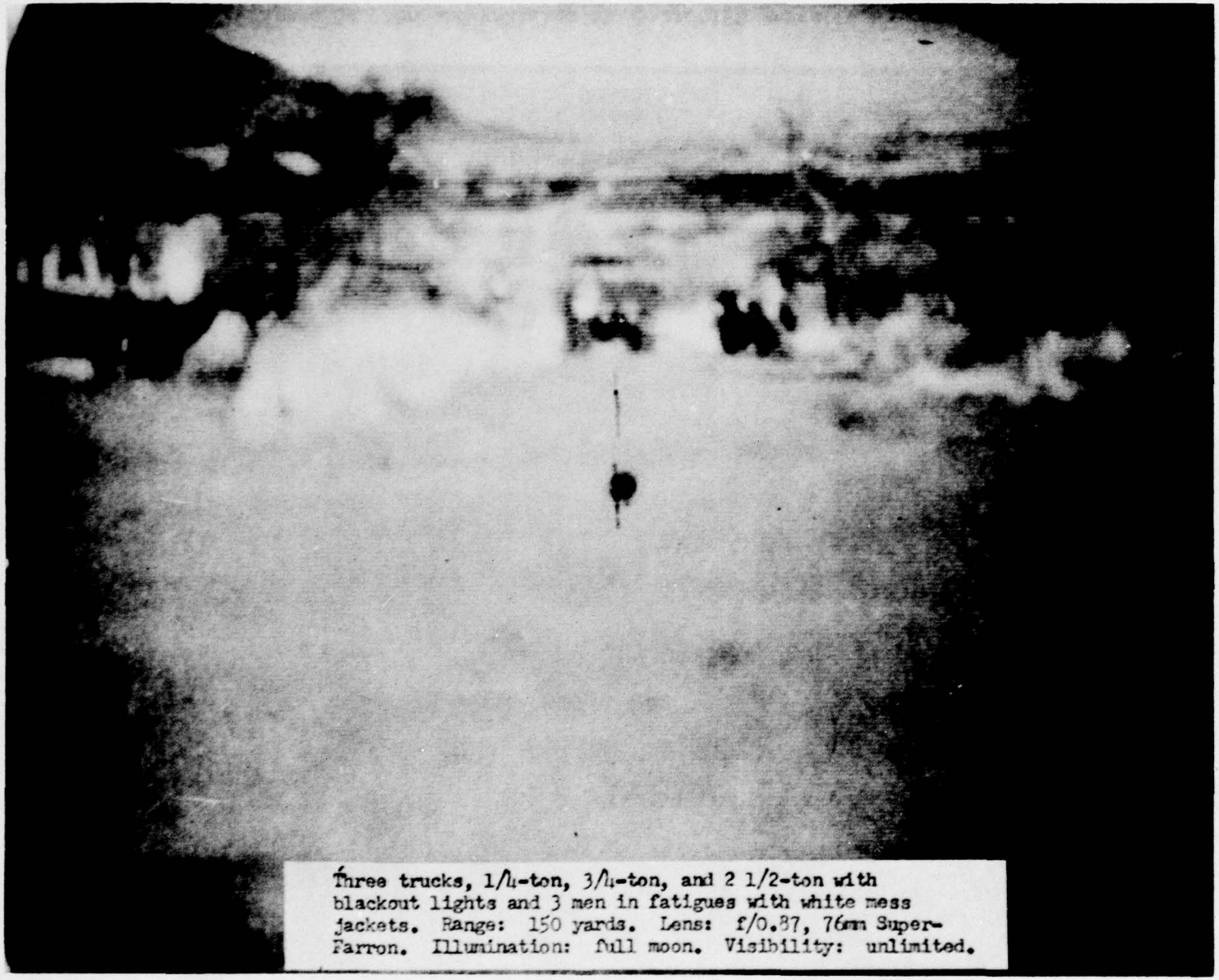

Figure 4. Men and vehicles at 150 yards (full moon)

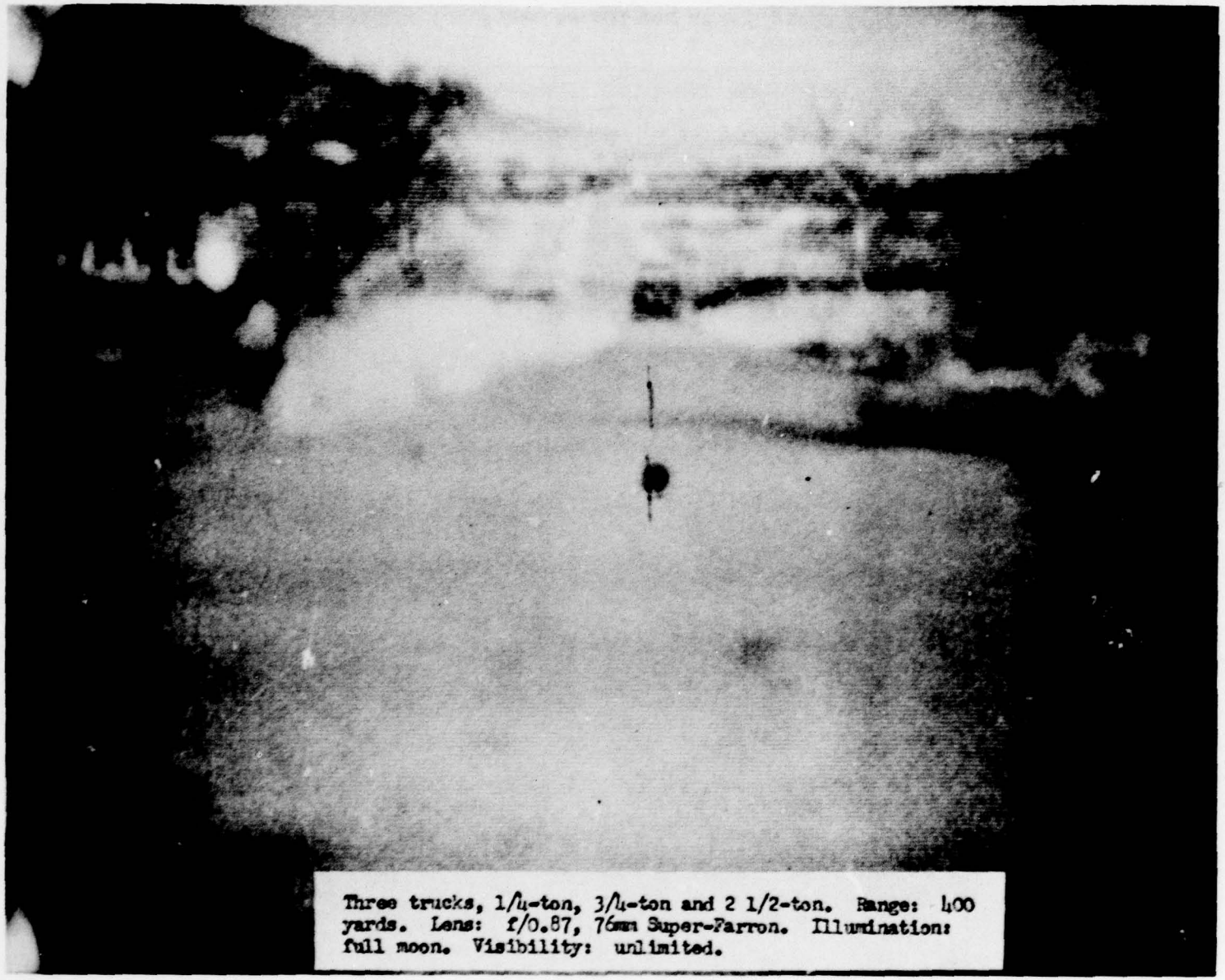

Figure 5. Vehicles at 400 yards (full moon)

Figure 6. Vehicles and men at 400 yards (full moon)

Three trucks, 1/4-ton, 3/4-ton, 2 1/2-ton and 3 men in fatigues with white mess jackets. Range: 400 yards. Lens: f/0.87, 76mm Super-Farron. Illumination: full moon. Visibility: unlimited.

Figure 7. Vehicles and men at 400 yards (full moon)

c. Results. Results indicated that:

(1) With the f/0.87 76mm lens, personnel, vehicles and buildings were identified at altitudes to 500 feet while the helicopter was hovering. Only buildings and vehicles were identifiable at altitudes above 500 feet to 1,500 feet while hovering.

(2) The maximum speed minimum altitude condition (velocity over height) encountered before detrimental picture smear was evident was 75 knots at 500 feet above terrain (Figure 8). At 1,000 feet and above there was no smear at 75 knots; however, only buildings were identifiable (Figure 9).

(3) The equipment was capable of yielding the above results only during the period 5 days before and 5 days after the full moon.

(4) Tests were conducted with no overcast and good visibility.

IV. CONCLUSIONS

It was concluded that:

1. The general concept has application to the combat surveillance system, but a more sensitive tube is required to make military use practical.

2. The speed of the f/0.87 lens appears adequate. The 76mm focal length is insufficient to detect targets at ranges in excess of 500 yards during periods of low illumination.

V. RECOMMENDATIONS

It is recommended that:

1. The 6849 Image Orthicon Camera Tube received no further consideration for combat surveillance system applications.

2. A more sensitive tube be developed. (This tube should be most sensitive in the yellow or red portions of the light spectrum since spectral energy is greatest in those regions during the hours of night sky illumination.)

3. A system having usable sensitivity at lower light levels down to 10^{-9} foot-candles (equivalent to overcast starlight) with suitable lenses should be developed.

Dirt road through grove of trees. Altitude: 500 feet. Speed: 25 knots. Illumination: full moon. Lens: f/0.87, 76mm Super-Farron. Visibility: unlimited.

Figure 8. View of dirt road from helicopter at 500 feet altitude (full moon)

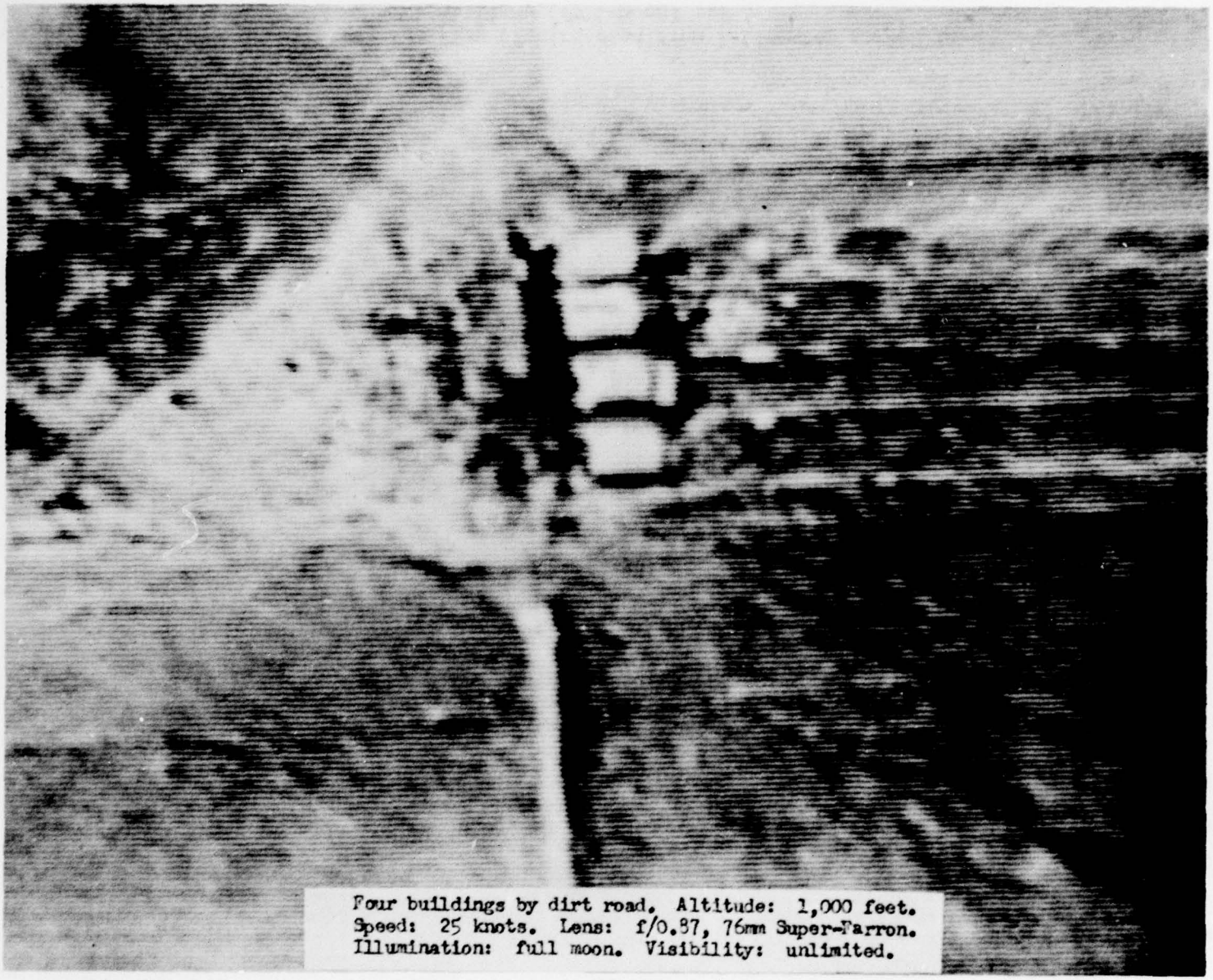

Figure 9. View of buildings from helicopter at 1,000 feet altitude (full moon)

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Tests were conducted to determine the effectiveness of the 6849 Image Orthicon TV Camera Tube as a light sensitive pickup device in a television system for use during the hours of darkness. It was concluded that type 6849 Image Orthicon TV Camera Tube does not possess adequate sensitivity to be utilized in television cameras for surveillance during the hours of darkness when illumination level is below 10^{-3} foot-candles. Although the general concept has application to the combat surveillance system, a more sensitive tube is required to make military use practical. It is recommended that this tube receive no further consideration for combat surveillance system applications but a more sensitive tube be developed.

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